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REPORT NUMBER 2

RESEARCH ON ACQUISITION OF SKILLS WITH SINGLE MOTOR UNIT TRAINING AND EEG

(Annual Report) ← Prior report limited

by

John V. Basmajian, M.D.

and

William D. McLeod, Ph.D.

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13. ABSTRACT

An experiment based on several pilot studies has been defined to investigate the sensory input, motor output co-relates within a single motor unit control task using EEG as the indicator of both sensory and motor response.

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OBJECTIVE

To investigate the possible existence of a covert sensory feedback from the single motor units event.

METHOD

Fifteen subjects each had a fine wire bi-polar electrode placed in their abductor digiti minimi muscle and were trained to fire a single motor unit (SMU) at a constant rate. The subjects were instructed to fire at whatever rate they would be able to maintain easily. The only sensory feedback signal about the SMU event was an auditory "click."

SUMMARY

The test described above was used to determine the design parameters of a random time delay generator that would enable the random delay of the auditory feedback from the SMU event. This would eliminate any signal timelocked to the single motor unit event in the EEG and would allow a thorough investigation of any potential evoked at the cortex by the single motor unit event. A series of experiments has been planned using the random time delay generator.

INTRODUCTION

The protocol described in our annual report #1 dated March 31, 1971, was carried out in middle May 1971. The basic purpose for this study was to investigate the possibility of uncovering a covert sensory

feedback signal indicating the occurence of the SMU event. The thesis under which this was investigated followed the same line of reasoning as the work in the delayed auditory feedback of speech and/or key tapping. When a subject is submitted to a time delay in the external feedback of his own speech, his performance deteriorates very badly with a delay in the neighborhood of 200 milliseconds. However, his performance regains substantially with a delay in the neighborhood of 500 milliseconds. This result indicates that he can ignore the external path and rely on other internal paths to be assured that he is speaking correctly. The objective of the experiments last May was to delay the single motor unit event and investigate the performance. EEGs were measured over the motor potential and the frontal lobe contralateral to the muscle being studied. The results from that set of experiments described in one of our quarterly progress reports this year indicated that although the performance deteriorated at a delay of approximately 200 milliseconds there was no recovery of performance when the aduitory delay was up in the region of 500 milliseconds.

The EEG data taken during that series of experiments was analyzed to determine whether or not any artifact in the EEG timelocked to the SMU event was observable. The main problem inherent with that specific investigation was that the auditory feedback signal did cause a timelock artifact to occur which tended to swamp out any specific SMU artifact. It would seem reasonable to hypothesize that when the delay in the auditory feedback signal is included in

the path that this specific auditory evoked potential would be moved aside and allow the existence of the SMU signal if it exists. However, the subject's performance in the single motor unit event was in most cases destroyed at a delay of greater than 180 milliseconds which disturbed the subject to a great extent. In some subjects there is a definite indication of an artifact in the EEG keyed to the single motor unit event; however, at the moment there is not a statistically significant signal detectable across subjects in the work done last spring.

As demonstrated in the tests of May, 1971, the subjects were able to demonstrate excellent single motor unit control with a time delay of up to 180 milliseconds. The delay periods used in that experiment were 100 milliseconds, 180 milliseconds, 200 milliseconds, 250 milliseconds and 500 milliseconds. More investigation was needed to determine the effects of short delays hence an experiment was designed to investigate the effects of time delays in the range of zero to 140 milliseconds on the individual's performance. If it could be demonstrated that the subject performs adequately with time delays of up to a specific value, the larger the better, then a random time delay could be inserted between the SMU event and the auditory signal fed back to the subject in order that the auditory evoked potential would no longer be time locked to the SMU event. A thorough investigation of the EEG prior to and following the single motor unit event to determine what, if any, timelocked artifacts were observable would then be feasible.

In our first annual report we described the study to be done investigating the preturbation that occurs on the EMG in the biceps muscle due to a "click" presented to the auditory system. In our experiments last May with the Army volunteers at Fort Knox, there was not a large preturbation evident in any one of these subjects, and, consequently, allowed no investigation into the influence on timing of single motor units due to the click stimulus.

This investigation will continue since subjects who evidenced this kind of reaction do not seem to be very plentiful.

METHOD

In the experiments performed last November to determine the effects of short term auditory delays, fifteen subjects were investigated as follows:

1. Fine wire intramuscular bi-polar electrodes were inserted in the abductor digiti minimi muscle to record the SMU events. In addition, surface electrodes were placed over shorthead of the biceps muscle. The subjects were then submitted to a random click stimulus of the same nature as the click feedback from the single motor unit event while they maintained a minimal contraction in their biceps muscle.

   The EMG from the biceps muscle was recorded along with the clicks and this signal was averaged to determine the preturbation existing in the biceps muscle following the click stimulus presented to the ear.

2. Following this initial stimulus, these subjects were instructed from a written set of instructions as to how they were to proceed

trying to gain control over a single motor unit. They were instructed to isolate a single motor unit and keep it firing at a relatively constant frequency. Their performance was monitored on line by a computer which was continuously displaying the histogram showing the time between SMU pulses. When the subject was able to control the unit with a standard deviation of no greater than 30 milliseconds, then the experimental protocol was followed as described below.

The subject was allowed to control the single motor unit for a period of 30 seconds with zero time delay inserted in the loop. Each 30 seconds thereafter, the delay was incremented by 20 milliseconds up to a maximum of 140 milliseconds. Following the 140 millisecond delay, the subject was again allowed the 30 second period with zero delay. The subject was then given a rest for two minutes and after that period the single motor unit was again started and the subject allowed time to demonstrate a reasonable standard deviation in the histogram of the time between pulses before proceeding with the insertion of delays. This epic however started with the 30 second period of zero delay and was then subjected to a 140 millisecond delay for 30 seconds and each 30 seconds thereafter the delay period was decremented by 20 milliseconds down to ard finishing up with a period of zero time delay for 30 seconds.

The performance in this task was assessed by the subject's ability to maintain the relatively narrow standard deviation of

the time between pulses of the single motor unit event.

RESULTS

Nearly all subjects were able to maintain a high level of performance with time delays up to and including 140 milliseconds irrespective of the order in which the delays were presented to them. This set of experiments justified the design and construction of the device that would insert a random delay ranging between zero and 140 milliseconds into the auditory feedback from the single motor unit event. Based upon the above described experiment it can be concluded that the insertion of such a device would not impede a subject's performance in controlling a single motor unit and would not upset the subjects to cause a disturbance in the relative EEGs. The box has been constructed and tested and a firm protocol is now being designed to be run in early June on about fifteen subjects. We have tested a preliminary protocol on two subjects and expect to run approximately six more pilot subjects before a finalized protocol can be established.